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Analyzing the Impact of Some Atmospheric Parameters on Human Respiratory Tract Infection in a North Western – Gusau – Region

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ABSTRACT
The relationship between upper and lower respiratory tract infections (URTI and LRTI) and the monthly average atmospheric parameters (rain fall, maximum and minimum temperature, relative humidity, wind speed and solar radiation) in Gusau local Government has been examined. The data for the Respiratory Tract Infection (RTI) cases were obtained from the Federal Medical Center (FMC)Gusau, while that of the atmospheric parameters of the same area were obtained from the Nigerian Meteorological Agency (NIMET). The datasets used spanned the period of two years, from 2019-2020. Results from the study revealed that 869 cases of RTI were recorded from January 2019 to December 2020 at FMC Gusau. Further observation from the results also revealed that children within the age of 0-5 years (53.13%) are mostly affected with the RTI, followed by those within the age bracket of 6-11 (21.80%) and the least is adults that are above 40 years (6.91%); This has evidently shown that the prevalence is high in children within the age bracket of $0 \geq 5$, and the chances of contracting RTI reduces as one grows older and lowest when people are above 40 years. The study also reveal that in terms of gender, adult female stand a high risk of contracting RTI in this location. This cannot be unconnected with their level of exposure to smoke and dust during their domestic activities. Results from the Atmospheric parameters shows a positive correlation between the RTI (URTI, LRTI), rainfall and relative humidity, and a negative correlation between RTI (URTI, LRTI) cases, maximum/minimum temperature, and solar radiation. These is evidently possible as a result of high concentration of dust particle that are usually noticed during the harmattan seasons and rainy seasons. Large amount of dust particles are usually experienced before the commencement of rains in this area, thus, the increase in the number of cases recorded during the rainy or wet seasons.

Key words: Respiratory Diseases, Atmosphere, URTI, LRTI, Gusau,

I. INTRODUCTION

The environmental conditions produced by different weather parameters such as temperature, wind speed, amount of rain fall, solar radiation and relative humidity are known to impact the quality of the surrounding ecosystem. Asthma is the one of those heath conditions which is induced and aggravated by changes in weather and climate as recently reported by David et al.(2021). This study investigates the relationship between some weather parameters (Temperature, Relative humidity, Wind Speed and Amount of Rainfall), on the incidence of Respiratory diseases in Gusau local Government area of North Western sub – region of Nigeria.

Respiratory tract infection (RTI), or lung diseases, are disorders such as asthma, pneumonia, tuberculosis, lung cancer. Worldwide, about 80 million people suffer from moderate or severe chronic obstructive pulmonary disease (COPD) and, according to the World Health Organization (WHO), is expected to become the third leading cause of death by 2030 (Dorteet al.,2015).

It's reported that in 1990, the WHO/World Bank global burden of disease have recorded the estimate of the global prevalence of chronic obstructive pulmonary diseases (CODP), to be

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about 9.33% per1000 people for men, and 7.33% per 1000 for women and prevalence was higher in industrialized countries (Aitkhaledet al., 2001). It is also clear that, the lower respiratory tract (LRT) diseases such as pneumonia, asthma, and lung cancercontinue to be a major cause of morbidity in Nigeria(Egbagbe and Mordi, 2006). This study has also shown that, the cases of LRT is mostly prevalent among children below Five years of age. Globally about 238 million people are affected out of which about 13 million deaths are recorded (Agnestet al.,2018).

Salma et al.(2018) has Shown that, in Nigeria, lower respiratory tract infections is the second leading cause of death in all age brackets in 2002, while tuberculosis(TB) was the seventh leading cause of death, with 4% of the total deaths recorded through the year. There are few studies on the morbidity and mortality pattern of respiratory tract infection in Africa and fewer still from Nigeria.This research work was focused on identifying the impact of some atmospheric parameters on the spread of respiratory diseases in North Western sub region (Gusau), Nigeria from the period of maximum to lower solar activity.

II. THEORY

Akinyemiet al.,(2011)studied the relationship between some weather parameters (relative humidity, rain fall and temperatures) and respiratory diseases in Eco-Climatic zone of Ile-Ife and Ilorin, and reported that 2,056 patients in Ile-Ife (humid zone) and 2,647 patients Ilorin (derived savannah) had a cases of respiratory diseases in each of the respective regions. According to their results, 60% of the cases recorded are within the age bracket of 0-5 years, and lower number of cases were recorded for people above 80 years. Recent investigation by Tatyanaet al., (2019) on the influence of atmospheric parameters and climate change on patient with respiratory diseases in maritime monsoon, used, short-term meteopathic reaction in patient with respiratory diseases to check the impact of "weather complex'', they reported that, the atmospheric parameters record on the day patients report to the hospital for examination and two days before the examination was assessed and correlated, and the results obtained, shows that maritime monsoon climate and atmospheric parameters have a negative impact on patients with respiratory diseases.

III. DATA AND METHODS

Two set of Data were used for this study, the first set of data is the atmospheric parameters data obtained from Nigeria Metrological Agency (NIMET) through,Gusau Metrological Center. This is the agency that is accredited for metrological data collection, documentation and dissemination. The atmospheric parameters used for this study includes; daily minimum and maximum temperature (^{0}C), relative humidity (mm), wind speed (m/s), solar radiation (w/m^2) and amount of rainfall (mm), and the datasets spans 2019 to 2020.Retrospective clinic data on respiratory tract infection werealso collected from the Federal Medical Center (FMC) Gusau from 2019 to 2020. The data was extracted from the diagnostic index card (DIC) of patients at the hospital, Which consist of age, sex, location, occupation, date and year the patient reported to the hospital, access to clinical data was granted after the ethical committee of the hospital examined the study proposal and clear it of any ethical implication.Quantitative analysis was employed to compute the monthly, seasonal and annual trend of respiratory diseases using available software such as excel spread sheet and Minitab.

3.1The Study Area

The city of Gusau is located in northwestern Nigeria, is the Capital city of Zamfara State. It is also one of the state`s local government area, which has an area of 3,364km^2 (2,090mi)^2 and a population of 383,162 as of the 2006 census. It is geographical coordinates are 12^0 9' 51" north, 6^0 40' 0''east.

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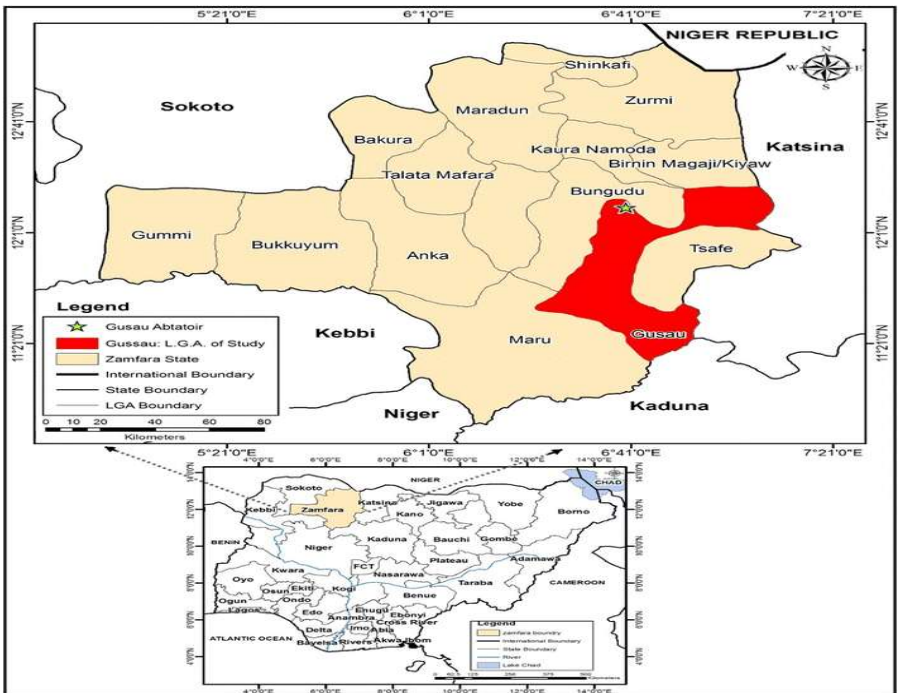

Figure 1: Map of Zamfara State showing Gusau Area (Red ink)
(Source: google.maps.com/Gusau area)

3.3**Methods of Data Analysis**

The daily data from the hospital which consistsofage, location, occupation,sex, month and year of reporting to the hospital, were collected from the hospital through the chairman ethic committee of the Federal Medical Center Gusau. The monthly averages of the data were computed. The method of age grouping by Yansui et al. (2020) and Abdullah et al. (2021) was adopted for this study. In this method, theageswere grouped as 0 -5, 6 -11, 12 -20, 21 – 40 and above 40. Monthly averages, of the data of some atmospheric parameters (daily minimum and maximum temperature, atmospheric pressure, relative humidity amount of rainfall solar radiation), were computed using excel spread sheet the equation; Mean = $\sum \frac{f}{n}$ where (f is the sum of frequency and n is the number of events)as adopted by some researchers (Rasheedat et al., 2020,Tal'yanet al., 2019, and Yansui et al., 2020).

To investigate the relationship between the atmospheric parameters and Respiratory Tract Infections, various graphs were plotted to check the relationship between atmospheric parameters and number of the cases recorded in each year of the study period, apart from the monthly and annual trends six season groups were adopted, this method was adopted by Oguntoke et al.(2019) and Akinyemi et al.(2011). In order to identify the specific atmospheric parameters that shows significant association with respiratory tract infections (URTI and LRTI) and those that explain the temporal pattern, correlation analysis were conducted and the data entry was done on Excel spread sheet and imported into Minitab for analysis.

IV. RESULTS AND DISCUSSION

4.1. Monthly variation of the occurrence of URTI and LRTI in 2019

Figure 2and 3 shows the monthly distribution of URTI and LRTI cases recorded in the year 2019, at FMC Gusau, in Figure 2, each month of the year shows the observation of the number of upper respiratory cases (blue bar), lower respiratory cases (red bar), number of males that were affected by both upper and lower respiratory cases (green bar), while the purple bar shows the number of females that were affected with both upper and lower respiratory diseases. Figure; 3 Shows the plot of ages distribution among the patient with upper and lower respiratory cases recorded in 2019. This figure deicts, the number of respiratory cases with age bracket between 0 – 5 (blue bar), age bracket 6 – 11 (red bar), age bracket between 12 – 20, (green bar) while (purple bar) is age bracket between 21 – 40, and lastly age bracket above 40 (blue green bar).

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An observation from Figures 2 reveal that significant number of upper respiratory cases were mostly recorded in the months of March and November followed by moths of April, February, September and October with maximum number of cases recorded in the month of March 2019, with a value of thirty two (32) cases. In contrast to URTI, the highest number of LRTI cases were recorded in the months of January, June, August, October and December 2019. The least number of the cases from Figure 2 were mostly observed in the months of May, June and July.

Further observation from the figure reveals that the number of URTI and LRTI in terms of gender varies from month to month, for instance, in the month of March 2019, a higher number of males were affected by both upper and lower respiratory cases, while months of March and November recorded higher number females with respiratory diseases. It is also evident that the number of cases recorded in the months of May, June, July, August and December were generally low and mostly highest in March and November 2019. Take a general annual statistic of the number of lower and upper respiratory cases, on average more cases of upper respiratory diseases were observed in 2019.

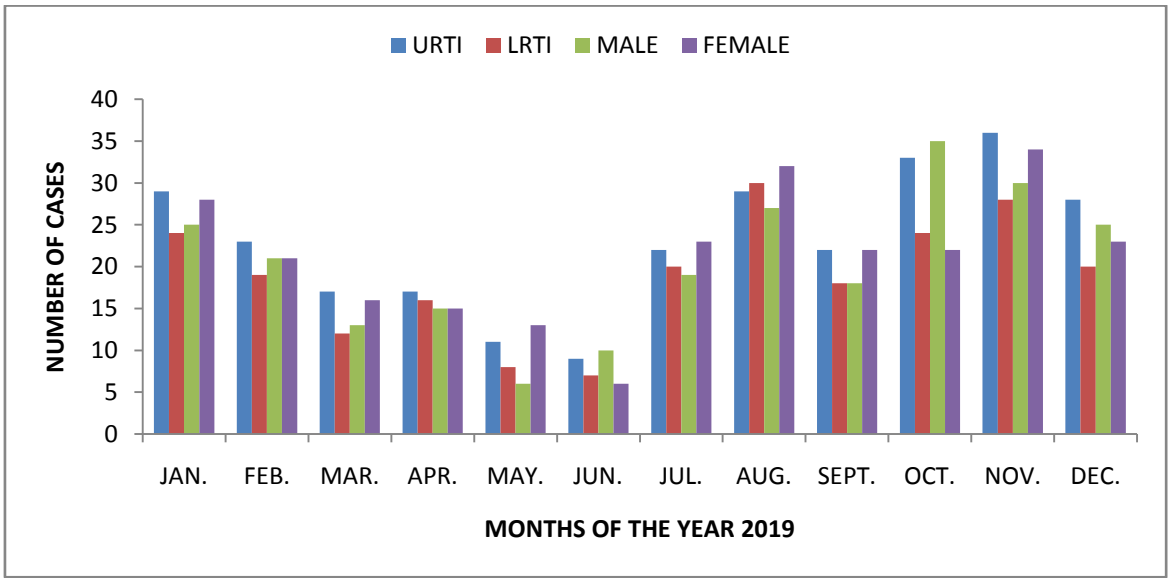

Figure 2 monthly distributions of URTI and LRTI recorded in 2019.

Observations from Figure 3 revealed that children with age bracket between (0 – 5) are mostly affected with both upper and lower respiratory diseases with maximum number of 180 cases recorded in 2019, followed by age bracket between 6 – 11 with 45 cases, further observations shows that age bracket between 21 – 40 recorded the least cases of both upper and lower respiratory cases in 2019.

Furthermore an observation from this Figure revealed that respiratory diseases can affect all genders. For instance in 2019, the number of females who were affected with the respiratory diseases were observed to be higher than their male counterparts. On the average, we can see a clear upward trend in the number of children with age bracket 0 – 5 having a higher prevalence of diseases then the adults.

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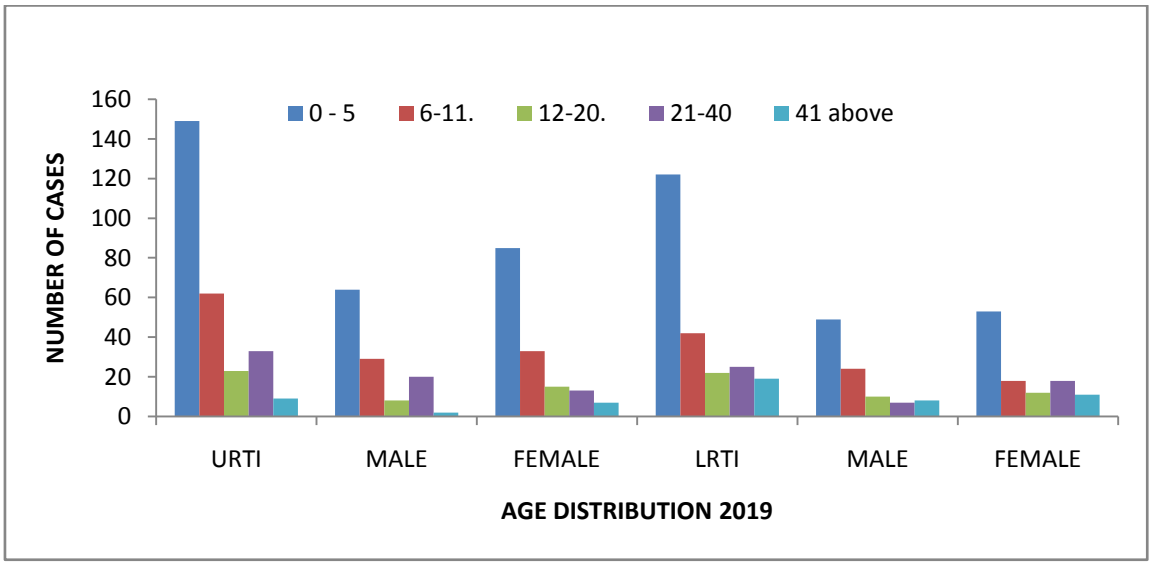

Figure 3 age distribution of URTI and LRTI recorded in 2019.

4.2. Monthly variation of the occurrence of URTI and LRTI in 2020

Figure; 4and 5 shows the monthly distribution of both URTI and LRTI cases recorded in a year 2020, in this figure, each month of the year shows the observations of the number of patients with URTI cases (blue bar), LRTI (red bar), number of males that were affected by both upper and lower respiratory cases (green bar) while the purple bar shows the number of female that were affected with both upper and lower respiratory diseases in the year 2020. Figure; 5, Shows the age distribution among the patient with URTI and LRTI cases recorded in 2020. The figure shows the number of respiratory cases with age bracket between 0 – 5 (blue bar), age bracket between 6 – 11 (red bar), however age bracket between 12 – 20, (green bar) while (purple bar) is age bracket between (21 – 40) and lastly age bracket above 40 (blue green bar).

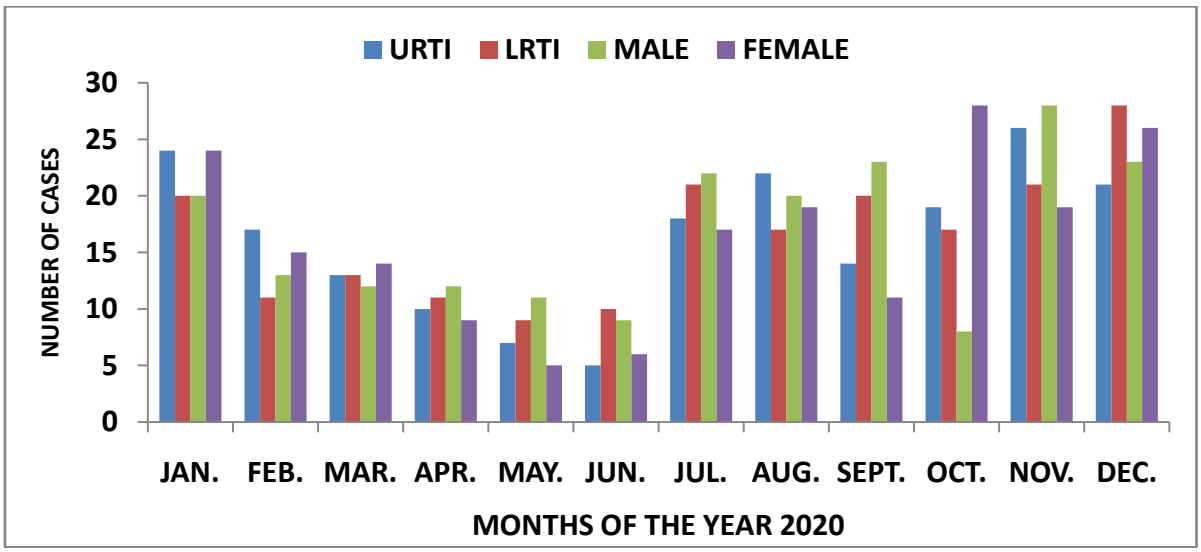

Figure 4 monthly distributions of URTI and LRTI recorded in 2020.

Observation from Figure 4 revealed that significant number of upper respiratory cases were observed in the months of January, February, August, October and November 2020, with maximum number of the cases with value 28 cases occurring in the month of November, on the other hand, the maximum number of LRTI cases were

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recorded in the months of April, May, June, July, September and December.

Further observation from Figure 4 reveals the number of RTI in terms of gender varies from month to month. For instance in the months of April, May, June, July August, September and November, higher number of males were affected by both upper and lower respiratory cases, while observations from the months of January, February, March and October shows the highest number of females that were affected with both URTI and LRTI.

It is also clearly observed that the number of cases recorded in the months of March, April, May and June were generally low and mostly highest in November, December and January 2020.

On the average, more cases of upper respiratory diseases were observed in the year 2020 and in terms of gender, females are more susceptible to the diseases that males, this cannot be unconnected with the nature of their domestic activities in this area. It is evident that females in this area are more exposed to dust and smoke than their male counterparts, they are mostly involved in cooking which is mostly done with fire wood and also the environment is mostly sandy and the females are always involved in sweeping the compound which further expose them to atmospheric dust from the ground and above the ground surface.

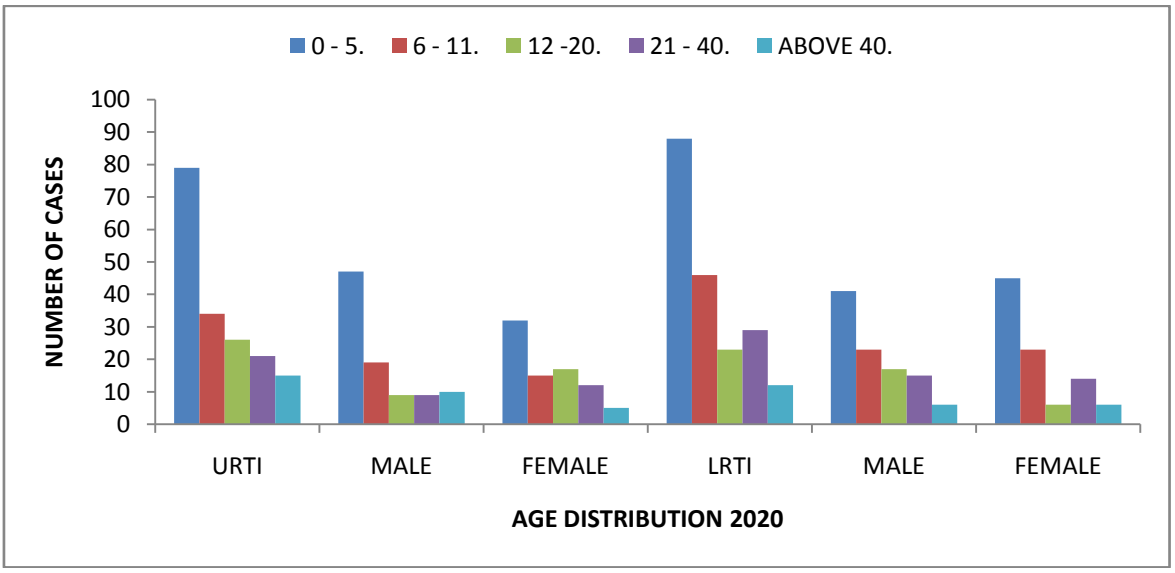

Figure 5 age distribution of URTI and LRTI recorded in 2020.

Observations from Figure 5, revealed that children within the age bracket between (0 – 5) are mostly affected with both upper and lower respiratory diseases with maximum number of cases recorded (with value of 70 cases) in the year 2020, followed by age bracket 6 – 11 with a value of 12 cases. The lowest number of cases were recorded within the age bracket of age that are above 40 year 2020, with value that is less than ten (> 10) cases. Further observations in this plot revealed that respiratory diseases can affect all genders. For an instance in 2020, a higher number of females with lower respiratory cases were observed, while higher number of males with upper respiratory cases were recorded. Averagely, children within the age bracket of 0 – 5 have a higher prevalence of contracting the URTI and LRTI diseases. The percentage values of occurrence of these diseases in the two years considered are recorded in Table 1 below;

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Table: 1 Percentage occurrences of upper respiratory tract infection (URTI), and lower respiratory tract infection (LRTI) in each year.

years	2019						2020					
Age bracket	URTI %	M%	F%	LRTI %	M %	F%	URTI%	M%	F%	LRTI %	M%	F%
0 ≥ 5	29.44	17.65	16.80	24.11	9.70	10.47	21.18	12.60	8.58	23.59	10.99	12.60
6 ≥ 11	12.25	5.73	6.52	8.30	4.74	3.56	9.12	5.09	4.02	12.33	6.17	6.17
12 ≥20	4.55	1.58	2.96	4.35	1.98	2.37	6.97	2.41	4.56	6.17	6.56	1.61
21 ≥40	6.52	3.95	2.57	4.94	1.38	3.56	5.63	2.41	3.22	7.77	4.02	3.75
41 ≥	1.79	0.39	1.38	3.75	1.58	2.17	4.02	2.68	1.34	3.22	1.61	1.61

Generally, a total of 869 cases of respiratory tract infection (RTI) were recorded during the study period, out of this number 417(48%) were males, and 452 (52%) were females. Similarly children within the age bracket of 0 - 5 are 438 (50.4%), 6 -11 were 184 (21.2%), 12 – 20 were 104(12.0%), 21 – 40 were 98(11.3%), and those above 40 years were 55(6.3%). This shows that the trend of the diseases decreases as the age increases.

Moreover observation from the Table 1 further revealed that URTI is the commonest disease for the children with age bracket 0 ≥ 5 in a year 2019, while in 2020, higher number of LRTI cases were recorded.

4.3. Relationship between LRTI, URTI and some Atmospheric Parameters

Figure; 6 is simultaneous increase in the amount of rainfall and the relative humidity. The plots of these parameters indicate a gradual increase in the amount of rainfall and the relative humidity, which began in the months of April and March respectively. It was further observed that both rainfall and Relative Humidity were at their maxima during the month August. These observations were simultaneous with the decrease observed in the maximum and minimum Temperatures, wind speed and solar radiation. It is of interest to note that these variations correlates well with the number of cases of both URTI and LRTI. In addition to that higher number of both URTI and LRTI were recorded mostly during the raining season, when the atmosphere is completely humid. It is however, evident to note that during these periods, the temperatures were relatively low as 28^0C and 24^0C respectively and humidity is high of 69% in the study area.

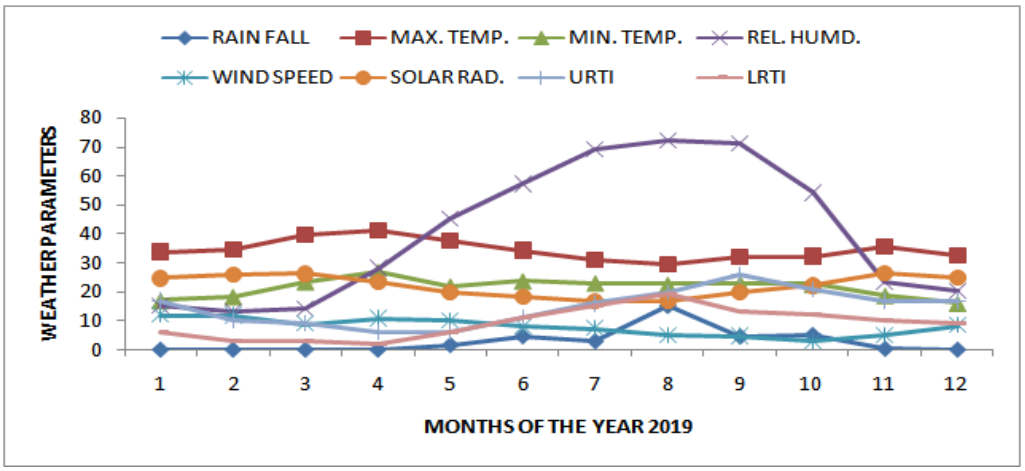

Figure: 6, Relationship between weather parameters and number of URTI and LRTI cases in 2019.

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Figure; 7 is the plot of relationship between trend of respiratory tract infection (URTI, LRTI) with average monthly atmospheric parameters (rain fall, maximum temperature, minimum temperature, wind speed, solar radiation and relative humidity) in a year 2020 of the study area.

An observation from the result shows that LRTI cases during the dry season, for an instant in the month of April the maximum temperature was high (38^0C) and number of cases was very only (2) cases were recorded, similarly URTI recorded only 3 cases. This result shows an inverse relationship between maximum and minimum temperatures with the incident of the number of cases in the study area Gusau. However more observation from the plot revealed that in the month of August maximum and minimum temperatures recorded the values (28^0C, 23^0C) respectively, at these temperatures the number of cases recorded the highest cases (URTI, LRTI) which values (27, 23) cases respectively.

More observation from the result shows that average monthly rainfall and relative humidity increases simultaneously, for an instant from January to April in Zamfara the study area there was no rain, also the relative humidity was low and number of the cases recorded the least values of both URTI and LRTI, this result shows that increases in rain fall and relative humidity enhance the spreading of both URTI and LRTI in Gusau the study area. However looking at solar radiation and wind speed, solar radiation shows same pattern with maximum and minimum temperature hence shows inverse relation with number of cases.

Further observation from the figure revealed that URTI and LRTI shows significant relationship with atmospheric parameters for instant in the beginning of the rainfall the relative humidity also gradually increases moreover maximum and minimum temperature decreases as shows in the figure above. However an observation from the plot revealed, the infection was associated with decreases in temperatures and solar radiation and increases in amount of rainfall and relative humidity.

The results of correlation test between RTI (URTI and LRTI), in Zamfara with monthly average metrological parameters (Rain fall, maximum and minimum temperature, wind speed, relative humidity, and solar radiation), shows a strong positive correlation exists between the incidence of the diseases (URTI, LRTI) with monthly average atmospheric parameters (rain fall and relative humidity) which values (58%, 74%), (54%, 80%) as revealed in the Table 2 respectively. In addition to that negative correlation exist between (URTI, LRTI) with average atmospheric parameters (maximum temperature, wind speed and solar radiation) within values of (35%, 51%, 54%), (34%, 44%, 54%) respectively.

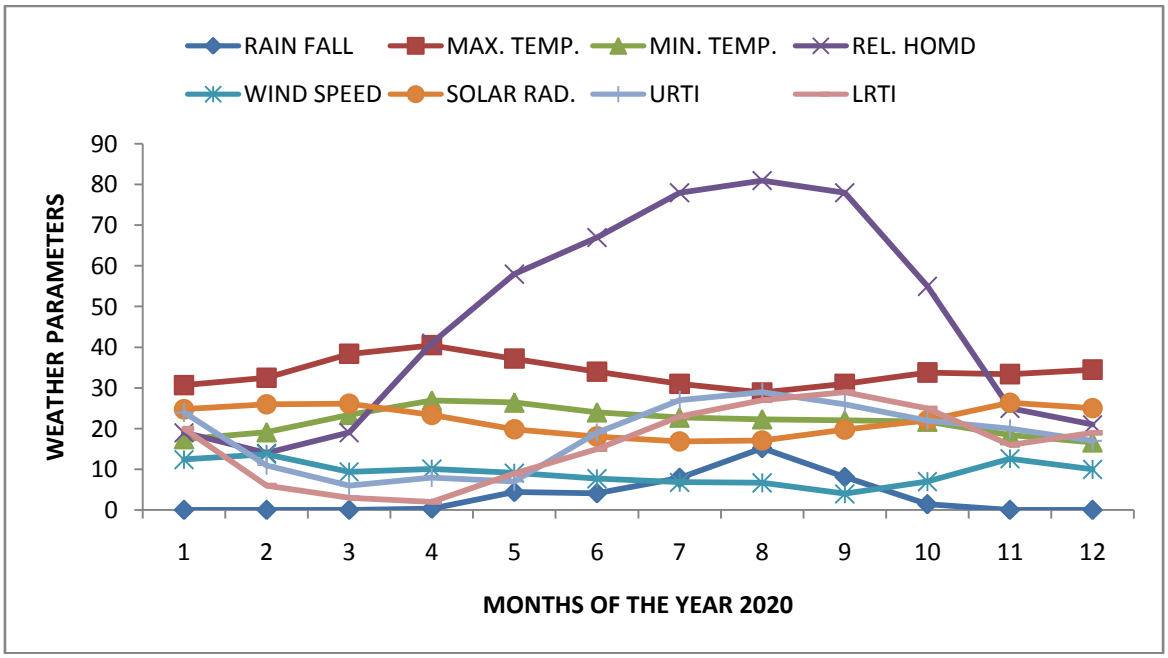

Figure: 7, Relationship between weather parameters and number of URTI and LRTI cases in 2020.

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4.4. Correlation between the Atmospheric Parameters and the number of URTI and LRTI cases recorded in 2019-2020

The results of correlation between the URTI and LRTI with the Atmospheric parameters is shown in Table 2. Observations from this table reveals both negative and positive correlation between the parameters considered. Significant correlation was observed between Minimum and maximum Temperature and both URTI and LRTI during the two years considered, this is followed by wind speed. Solar radiation and wind speed however, respectively show negative and positive correlation with the LRTI in 2020.

A careful observation from the table further reveal that, there is a significant relationship with a correlation value that is greater than 0.5 (>0.5) between the Atmospheric/weather parameters and LRTI in 2020. Averagely, higher correlation values between LRTI and the weather parameters were evident in 2020. This is indicative of the fact that the LRTI are likely to be influenced significantly by the Atmospheric parameters than other factors.

Table: 2 Correlation between weather parameters and number of cases from 2019 to 2020.

	RAIN FALL (mm)	MAX. TEMP (^{0}C)	MIN. TEMP. (^{0}C)	WIND SPD. (m/s)	SOLAR RAD. (w/m^2)	R/HUMIDITY (%)
2019 URTI.	Corrl. 0.132 p-value 0.683	Corrl. -0.459 p-value 0.133	Corrl. -0.531 p-value 0.076	Corrl. -0.459 p-value 0.133	Corrl. 0.330 p-value 0.295	Corrl. 0.198 p-value 0.537
2019 LRTI.	Corrl. 0.359 p-value 0.252	Corrl. -0.533 p-value 0.074	Corrl. -0.383 p-value 0.219	Corrl. -0.429 p-value 0.164	Corrl. 0.118 p-value 0.716	Corrl. 0.095 p-value 0.770
2020 URTI.	Corrl. 0.258 p-value 0.418	Corrl. -0.766 p-value 0.004	Corrl. -0.671 p-value 0.017	Corrl. -0.137 p-value 0.671	Corrl. -0.146 p-value 0.650	Corrl. 0.189 p-value 0.556
2020 LRTI.	Corrl. 0.596 p-value 0.041	Corrl. -0.809 p-value 0.001	Corrl. -0.350 p-value 0.265	Corrl. -0.595 p-value 0.014	Corrl. -0.514 p-value 0.088	Corrl. 0.580 p-value 0.048

V. CONCLUSION AND RECOMMENDATION

This study analyzed the relationship between upper and lower respiratory tract infections (URTI, LRTI) and atmospheric parameters in Gusau, the north western region of Nigeria. Results from this study which revealed that there was as significant increase in number of cases with the variation in some atmospheric parameters and the season of the year. Most importantly, it was observed that the LRTI are likely to be influenced significantly by the Atmospheric parameters than other factors. The monthly variation of the occurrence of the URTI and LRTI also revealed that they are mostly prevalence during the harmattan and the raining season when the level of dust particle in the atmosphere is mostly higher.

Furthermore, RTI cases which were more prevalent among the children within the age bracket of $0 \geq 5$ years. The study further shows that female in the area have a higher possibility of contracting the RTI diseases compared to their male counterparts.

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